

7/18/86

GENERAL ELECTRIC

C50E69

TRANSPORTATION SYSTEMS BUSINESS OPERATIONS
SPECIFICATION AND PROPERTIES

S 2

Order and Correspondence Must
Specify Complete Number

TITLE

SPECIAL ALLOY GRAY IRON MAIN FRAME CASTINGS

1. SCOPE:

General Electric Material C50E69 identifies a special alloy gray iron diesel engine main frame casting, the condition of which is designated as follows:

C50E69A - MAIN FRAME CASTING WITH NUT POCKETS - 37,500 psi minimum tensile strength in heavy wall critical sections, electric melt or electric holding furnace

C50E69B - MAIN FRAME CASTING WITHOUT NUT POCKETS - 32,500 psi minimum tensile strength in heavy wall critical sections, electric melt or electric holding furnace

2. CHEMICAL COMPOSITION:

2.1 General: It is the intent of this specification to subordinate chemical composition to mechanical properties and microstructure, however the chemical composition shall be mutually agreed upon. No deviation from the approved chemical composition shall be allowed without written permission from General Electric. The approved chemistry shall be agreed to by the foundry and General Electric.

2.2 Chemistry Recommendations

<u>ELEMENT (WT. %)</u>	<u>C50E69A</u>	<u>C50E69B</u>
Carbon Equivalent*	3.60-3.90	3.60-3.90
Carbon	3.05-3.30	3.05-3.30
Silicon	1.55-2.10	1.55-2.10
Manganese	.65-1.10	.65-1.10
Phosphorus	.090 Max.	.090 Max.
Sulfur	.030-.100	.030-.100
Nickel	.60 Max.	.60 Max.
Chromium	.20 Max.	.20 Max.
Molybdenum	.40-.60	.25-.35
Copper	.40-.60	.25-.35
Vanadium	.05 Max.	.05 Max.
Nitrogen	60-120 ppm	60-120 ppm
Lead	.005 Max.	.005 Max.
Titanium	.025 Max.	.025 Max.
Tellurium	.020 Max.	.020 Max.

* C.E. = Total Carbon + 1/3 (Si+P)

DATE OF
ISSUE

1/29/88

WRITTEN
BY

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3. MECHANICAL PROPERTIES:

- 3.1 General: It is the intent of this specification that the castings themselves have the specified tensile strength. All castings to C50E69A shall have a minimum tensile strength of 37,500 psi in the heavy wall critical sections (nut pocket area - see Figure #2) of the casting. To insure this strength level, cast-in-mold test bars shall meet the tensile strength specified in Section 3.2.

- 3.2 Tensile Strength Requirements: The basis of acceptance for each main frame casting shall be the tensile test results from the 6" x 6" cast-in-mold test blocks. The location and sectioning of the test block is shown on the individual frame casting drawings and in Figures 1-3 of this specification. These test bars shall meet the following requirements in the 6" x 6" cast-in-mold block::

<u>Designation</u>	<u>Machined Location</u>	<u>Tensile Strength</u>
C50E69A	Mid-radius	37,500 psi Minimum
C50E69B	" "	32,500 psi Minimum

- 3.3 Hardness: It is necessary to control the hardness of the casting to prevent machining problems. Hardness testing shall be done by the Foundry and reported on the form in Figure #5. The casting and test bar shall meet the hardness requirements in the areas indicated below:

241 HB Maximum on cylinder deck and pan rail.
269 HB Maximum on sides near crankcase doors.
170 HB Minimum on crankcase bearing boss.

4. MICROSTRUCTURE:

- 4.1 General: The microstructure, throughout the casting, shall consist of predominantly Type A graphite in a pearlitic matrix. Non-standard graphite type such as "Mesh" graphite shall not be acceptable in amounts over 10% of the overall structure. Ferrite shall not represent more than 5% of the overall structure.
- 4.2 Graphite Flake Size: The graphite flake size shall be predominantly A.S.T.M. size 4 or finer. A small amount of A.S.T.M. graphite flake size 2 or 3 is acceptable. Flake size shall be determined at the mid-radius test bar location of the 6" x 6" cast-in-mold test block.

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- 4.3 Carbide Content: No chilled iron structure shall be allowed on the machined surfaces of the casting. Intercellular carbides shall not be allowed over 2% by volume. The intercellular carbide condition of the casting shall be determined metallographically at the mid-radius test bar location of the 6" x 6" cast-in-mold test block.

5. MANUFACTURE:

- 5.1 General: Manufacturing methods and processes in the foundry for casting the main frame and the systems for their control shall be subject to approval by the General Electric Company. Casting quality and dimensional tolerances shall be in accordance with the applicable drawings. Castings shall have acceptable machineability on the main frame machining line in the GE Grove City Plant.

- 5.2 Inoculation: The casting shall be inoculated in the ladle and in the mold to obtain a fine graphite structure and reduce the tendency to chill. The inoculation practice shall be approved during the qualification process and not changed without written permission from General Electric.

- 5.3 Times and Temperatures: The recommended pouring time is 60 seconds. The recommended pouring temperature range is 2450-2500°F. A minimum mold cooling time of 120 hours prior to shake-out is required.

- 5.4 Welding: No welding of any kind shall be permitted without specific approval of General Electric Diesel Engine Engineering.

6. VENDOR QUALIFICATION

- 6.1 General: Qualification of a foundry to produce main frame castings to C50E69A shall be based on achieving the minimum specified tensile strength at the critical heavy wall nut pocket location in the castings (see Figures 1 and 2). The trial frames shall be cast with the 6"x6"x18" test block as shown in Figures 1 and 2. Tensile specimens shall be cut from the critical location in the casting and from the half radius position in the test block (see Figure 3). Tests shall be made to determine the tensile strength correlation between the casting and the test bars.

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6.2 Foundry Process: The foundry process shall be developed to produce main frame castings above the specified tensile strength level, with the appropriate hardness and microstructure and consistent quality. The process shall not be changed without permission from GE. Process records shall be maintained at the foundry for the following:

- 1) Raw Material Charge - Proportion and quality of steel, returns, scrap, pig iron, etc.
- 2) Melting Practice - Time and maximum temperature of melting process, melting rate, hold time, control parameters, and tapping temperature.
- 3) Alloying Practice - Timing, quantity and form of alloy additions, stirring of ladle. Chemical composition check procedures. Temperature adjustment procedures.
- 4) Inoculation Practice - Timing, quantity, form, metal temperature and brand name of inoculant. Size and location of in mold inoculant.
- 5) Pouring - Time from tap and inoculation, and pouring temperature, rate, and duration.
- 6) Shake Out - Time since pour and metal temperature.
- 7) Cleaning - Cleaning and inspection procedure, time and intensity of blast operations, documentation of authorized repairs, rust preventative application.
- 8) Molding - Sand composition and binder system, washes and coatings, dimensional control of cores and mold, sand QC procedure. Size, material, and placement of chills. Casting feeding system, pouring basin, slag control features, runners, gates, and risers. Geometry and construction of cores and molds.

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- 9) Quality Assurance - Positions and orientations of test bars for tensile tests, hardness tests, and microstructure evaluation. Tensile specimen design and test procedure. Sampling and test procedure for chemical analysis. Sampling and test procedure for process checks: liquidous carbon equivalent, chill wedge, etc.

7. ACCEPTANCE CRITERIA

- 7.1 Mechanical Properties: The main frame casting shall be accepted based on the tensile strength minimums specified in Section 3.2. The tensile test specimens shall be cut from the 6" X 6" cast-in-mold test block from the location shown in Figures 1-3. The foundry shall perform the required tensile tests on each casting.
- 7.2 Hardness: The casting shall be accepted based on the surface hardness of the pan rail, cylinder decks, and crankcase door openings.
- 7.3 Microstructure: The casting shall be accepted based on the inter-cellular carbide content and graphite flake size of the mid-radius of the 6" x 6" test block (see Figure #3). A metallographic specimen may also be taken from the Trepan or pan rail if deemed necessary by General Electric.

8. REFEREE METHODS:

- 8.1 Tensile Testing-----ASTM-E8, using the specimen in Figure 4.
- 8.2 Brinell Hardness-----ASTM-E10
- 8.3 Microstructure-----ASTM-A247

9. IDENTIFICATION:

The drawing and pattern number and cast date, and suitable identification to designate the manufacturer shall be permanently marked on each casting on the right-hand side of the front foot in the area where this surface is not to be later machined. Any hand stamping shall be in a non-critical area designated on the drawing.

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10. TOLERANCES:

As indicated on the drawing and Applied Practices.

11. REPORTS:

11.1 The supplier of castings to C50E69 must submit a certificate of test on the form shown in Figure #5. The following data shall be reported:

- a. Chemical analysis including total carbon, Si, Mn, S, P, Cu, Sn, Ni, Cr, Mo, V, Ti, Pb, Te, N (and other elements when added intentionally as a process requirement, e.g., Mg or Ca, or suspected of being present as residual tramp elements, e.g. Zn).
- b. Carbon equivalent (by calculation).
- c. Amount, type, and location of inoculant.
- d. Time (clock reading) when inoculant is added to ladle.
- e. Time (clock reading) when pouring from ladle to mold is begun.
- f. Running time (elapsed time from metal entering sprue to the time metal completely fills the mold).
- g. Ladle temperature (measured by immersion thermocouple) and time at which the reading was taken. The recommended pouring temperature range is 2450-2500°F.
- h. Ladle identification (Serial No.).
- i. Furnace identification (type, number, location, etc.).
- j. Casting identification (Serial No. or cast date).
- k. Date casting poured.
- l. Shake-out date (and time).

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m. Chill as measured from a standard ASTM-A367 wedge; state which wedge used (recommended W3 or W4 from the ladle as final chemistry is achieved).

n. Cast-in-mold test bar.

1) Tensile strength on the 6" x 6" x 18" bar.

2) Microstructure on the surface of the test bar from the mid-radius of the 6" x 6" x 18" test bar.

o Brinell Hardness (HB)

1) Cylinder Deck and Pan Rail.

2) Crankcase Door Openings.

3) Crankcase Bearing Boss.

11.2 The remaining half of the cast-in-mold 6" x 6" x 18" test block, properly identified, shall be shipped to General Electric Company with each main frame casting.

11.3 Process control and conformance data including complete chemical composition per Section 11.1 and microstructure per Section 4 shall be maintained on file for a minimum of seven years by the vendor and shall be supplied on request. All conformance data must be referenced to frame casting serial number or cast dates.

11.4 Deviations from this specification or the applicable drawing must have prior approval by General Electric Diesel Engine Quality Control on Form TSBO-2795-A prior to shipment.

12. PROTECTIVE TREATMENT:

Main frame castings shall be protected against corrosion by an approved crankcase rust preventive or paint as specified on the applicable drawing.

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Custom and Compliance Mark
 Specify Compliance Number

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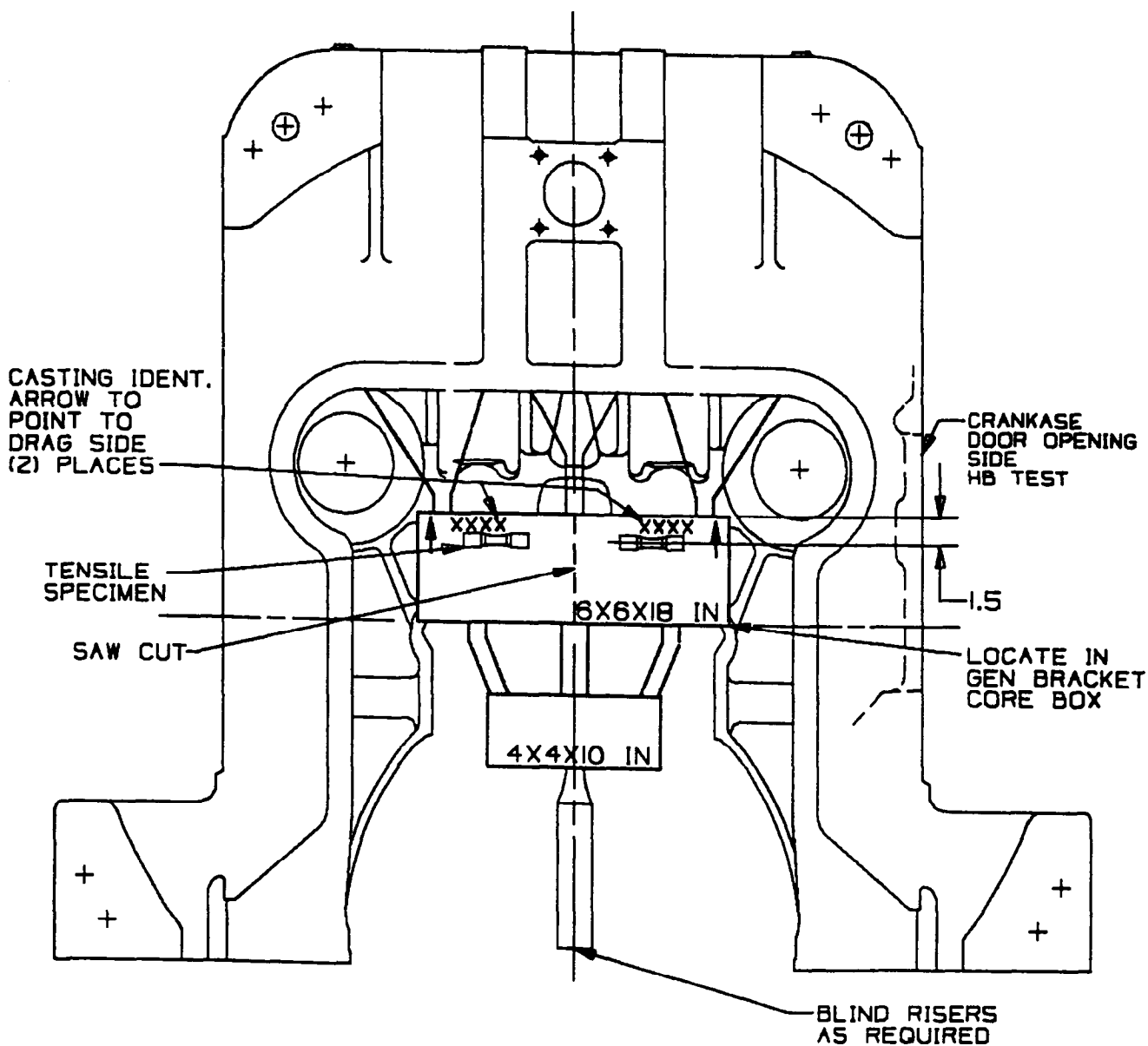


Figure 1. Main Frame Casting Test Bar Locations

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CYL BANK
LOC FOR
HB TESTCYLINDER
BORECRITICAL NUT
POCKET AREA
TENSILE TEST
LOCATIONSPAN RAIL
HARDNESSBLIND RISERS
AS REQUIRED

Figure 2. Main Frame Casting Test Bar Locations

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ISSUE 1/29/88WRITTEN BY *Thomas E. Johnson*
BY T.E. JohnsonAPPROVED BY *R.F. Fischer*
BY R.F. Fischer

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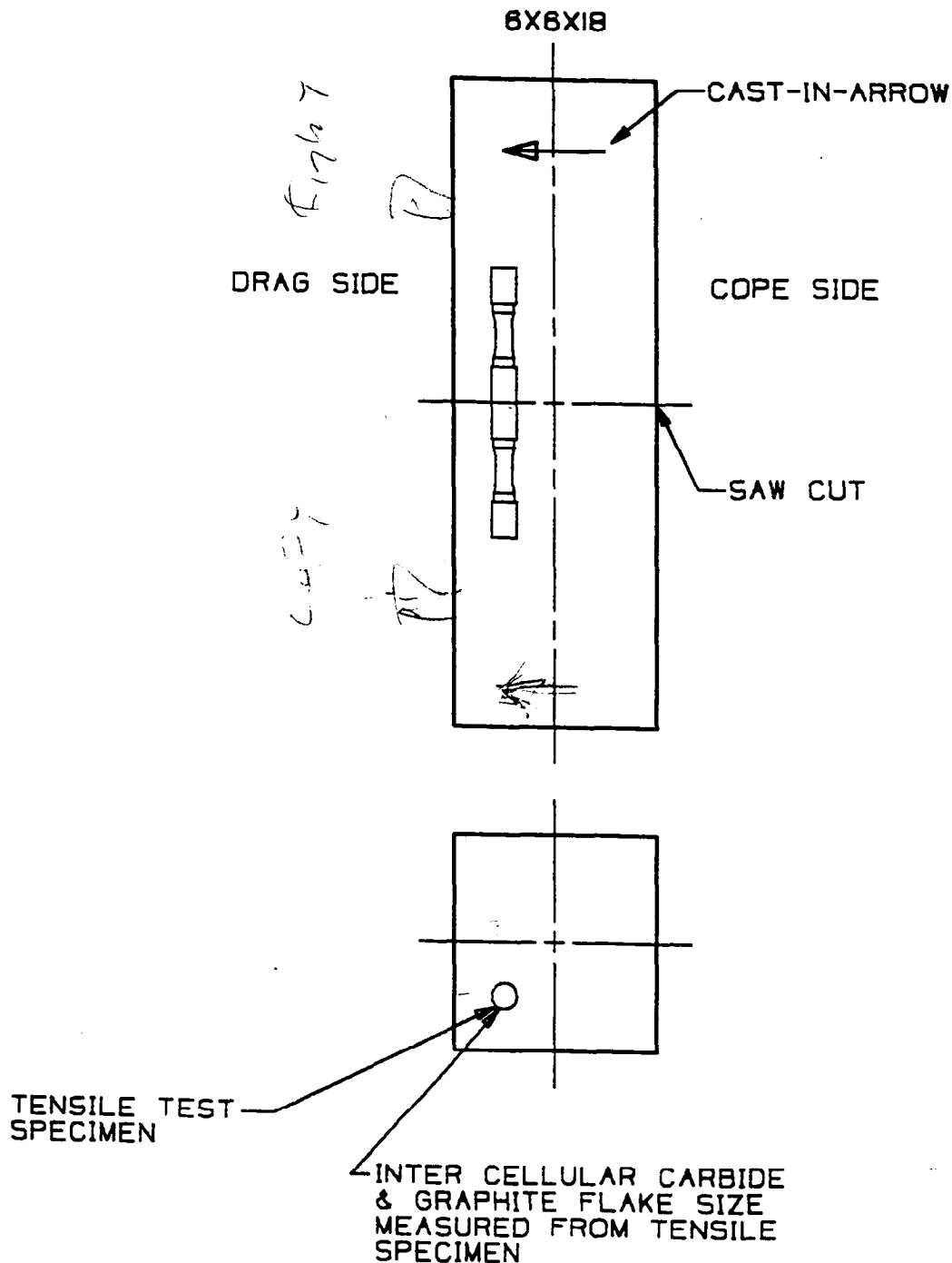


Figure 3. Acceptance Test Locations in Cast-On Test Bars

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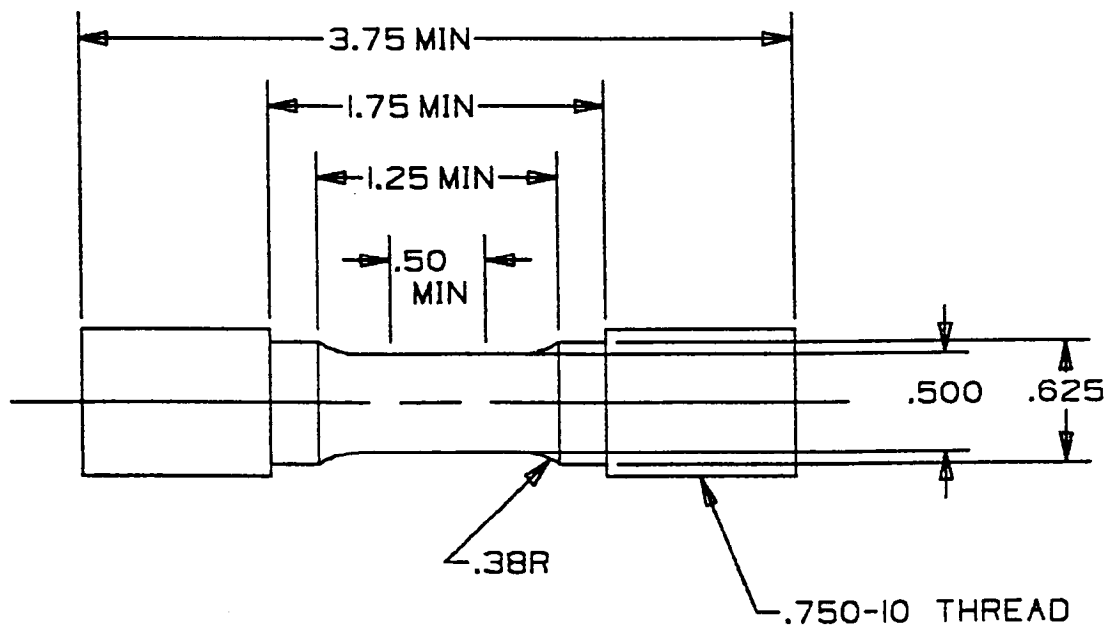


Figure 4. ASTM E8 Cast Iron Tensile Test Specimen

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VENDOR NAME AND ADDRESS: _____

PURCH. ORDER # _____

CASTING IDENT. NO. (CSTG. SER. NO. OR DATE) _____

PART NAME (8, 12, 16 CYL. MN. FR.) _____

DATE & TIME OF CAST _____

CASTING WEIGHT _____

SHAKE OUT DATE AND TIME _____

PATTERN NO. _____

FURNACE IDENTIFICATION _____

LADLE IDENTIFICATION _____

I. FOUNDRY PROCESSA. CHEMICAL COMPOSITION (WT. %)

C.E.	C	SI	MN	P	S	NI	CR	MO	CU	N
------	---	----	----	---	---	----	----	----	----	---

Sn	V	Ti	Pb	Te
----	---	----	----	----

 B. CLOCK TIMES AND TEMPERATURES
 (IMMERSION THERMOCOUPLE)

	<u>TIME</u>	<u>TEMP</u>
1. FINAL TAP	_____	_____
2. LADLE INOCULANT ADDED	_____	_____
3. CASTING POUR BEGAN	_____	_____

C. ELAPSED TIMES

	<u>TIME</u>
1. HOLD TIME (FINAL TAP TO INOCULANT)	_____
2. HOLD TIME (INOCULANT TO START OF POUR)	_____
3. TIME OF POUR (START TO FULL MOLD)	_____

D. FINAL CHILL (ASTM A367) WEDGE TYPE _____ MEASUREMENT _____

E. INNOCULANT TYPE _____ AMOUNT _____

II. ACCEPTANCE CRITERIA

6" X 6" MID RADIUS

1. TENSILE STRENGTH _____

2. HARDNESS: CYLINDER DECK AND PAN RAIL _____

CRANKCASE DOORS _____

CRANKCASE BEARING BOSS _____

3. MICROSTRUCTURE (LAB REF. NO. _____)

a) CAST IRON MATRIX (VOLUME %) _____b) GRAPHITE FLAKE SIZE (Cont'd) _____

FERRITE CONTENT _____

CARBIDE CONTENT _____

b) GRAPHITE FLAKE SIZE _____c) INTERCELLULAR CARBIDES (VOLUME %) _____

PREDOMINATE TYPE _____

SIZE _____

OTHER TYPE _____

SIZE _____

(6" X 6" TEST BAR) _____

I certify this casting meets the requirements of C50E69 S2 and the specified pattern number.

Signed: _____

DATE _____

Title: _____

Figure 5